Mechanisms of human malfunction definition of categories: Revisions and examples

Pedersen, O.M.; Rasmussen, J.

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MECHANISMS OF HUMAN MALFUNCTION
DEFINITION OF CATEGORIES: REVISIONS AND EXAMPLES

O.M. Pedersen and Jens Rasmussen

Addendum to N-15-80: Classification System Proposed
for Reporting Events Involving Human Malfunction

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INTRODUCTION

This note is part of a continuing work to improve the applicability of the human malfunction mechanism classification to event reports on one side and on the other side to identify the needs for supplementary information in event reports.

All the examples except one are from:

Nuclear Power Experience, Vol. PWR-2, XVI Operational Problems, C Miscellaneous. Edited by Nuclear Power Experience Inc., P.O. Box 544, Encino, California, U.S.A. The November 1975 state of the compilation was used.

One example under 13.1.3 is from:

Rasmussen, J. (1978), "Notes on Human Error Analysis and Prediction". Riso-M-2139. Riso 1978.

13. MECHANISMS OF HUMAN MALFUNCTION

13.1 Discrimination

This group is related to the man's ability to discriminate between and select the proper mode of control of his activities. The subcategories of malfunction mechanisms are characterized by interference between the man's repertoire of stereotyped habitual - and often subconscious - responses on one side and on the other side aspects of the actual work situation during infrequent and unique task demands.

13.1.1 Stereotype (skill) fixation, Definition:

Man operates in skill-based domain. He does not recognize a situation calling for attention and caution.

(Cues for recognition may not be present or may be overlooked, this is characterised by category 12: Cause of human malfunction, or 11: Internal human malfunction).

13.1.1 Stereotype (skill) fixation, Examples:

220. RECORDING ERROR - OVEREXPOSURE

Robinson 2 - May 75 - cold shutdown

The error in recording exposures occurred on May 6 when the Teledyne TLD badge of the individual in question was sent for routine processing. When the results were sent to the exposure record area, the H.P. Technician in charge of posting doses mistakenly recorded the exposure of 721 mrem for the employee on the exposure sheet of another employee with a similar name. The exposure was uniquely identified by a number assigned to the individual, but the person posting the exposure relied on the person's name rather than cross checking the number. The names of the 2 people involved were both listed with the same first initial and last name.

Identifying people by names is a stereotype skill which is ambiguous and in this specific task should be replaced by the numbers.

69. BORIC ACID VALVE MALFUNCTION - OPER.ATOR FEVER USED AS STEPPING POINT

Palisades - Aug 73

The valve location is such that it was Suspected that the valve (hence, the lever) may have been used as a convenient stepping point during construction and early operation of the plant.

The people using the valve as a stepping point are assumed to have been occupied by skill-based tasks not involving knowledge of valves and their properties.

13.1.2 Familiar association short-cut, Definition:

It is recognized, that conscious identification of the situation is needed but familiar cues activate incorrect intention and task in man. It is not recognized that knowledge-based evaluation and planning is needed.

13.1.2 Familiar association short-cut, Examples:

133. LIFTED LEADS NOT LOGGED - BOTH DIESEL FUEL FLOW PATHS OUT

Surry 2 - Sept 74 - cold shutdown

The valves were removed, repaired, and re-installed. The responsibility for re-connecting the valves was then given to a different group of electricians. The solenoids were re-connected at the valves themselves, but not iii the terminal boxes. Flow path operability was erroneously verified by an operator and an electrician by energizing each fuel oil transfer pump, one at a time, and listening for solenoid valve operation. Based on information provided to him, the Shift Supervisor noted in his log that 2 flow paths had been re-established.

The men expected to hear the sound of operating solenoid valves and hence they erroneously perceived the sound in spite of its definite absence.

189. EXCESSIVE CONTROL ROD MISALIGNMENT - FAILURE TO PROMPTLY INVESTIGATE CAUSE.

Three Mi. Is. 1 - Feb 75 - 100% power

Due to occasional past problems with inaccurate absolute position indications, the operators concluded this indication was in error and the absolute position bypass switch was placed in the bypass position (defeating the automatic alarm, out motion inhibiting and runback functions for this rod).

206. ALARM INCORRECTLY IDENTIFIED - LOW TANK LEVEL

Oconee 2 - Mar -5 - 100% power

Immediately prior to this incident, the alarm next to the quench tank low level alarm had been intermittently alarming. The operator heard the audio portion of the alarm, looked up, and mistakenly thought this alarm was the intermittent alarm again.

13.1.3 Stereotype take-over, Definition:

Task or act according to proper intention, but "absentmindedness" during performance leads to relapse to stereotype action links related to different act or task.

13.1.3 Stereotype take-over, Examples:

134 INTERNAL CONTAMINATION FROM OPENING VACUUM CLEANER

Robinson 2 - June 74

Following plugging of steel generators, cleanup of the channel heads was begun. A contractor employee was supervising the effort. In his desire to speed the job up, he decided to directly aid in the work.

After properly dressing for work In the steam generators, but prior to obtaining his respirator, the man checked the vacuum cleaner and found It to be inoperable. He opened the vacuum cleaner to attempt to repair it. Although the individual was very well-trained and experienced from many years of work with nuclear systems, he failed to consider possible radiological hazards when opening the vacuum cleaner which was clearly marked as being contaminated.

The actual situation as a whole: directly aiding the cleanup work, was not a routine, as the man's job was to supervise the cleanup work. However, to check and open the vacuum cleaner was a familiar routine to him. Instead of properly finishing protection of himself against contaminated dust by putting on his respirator, he starts checking and opening the vacuum cleaner.

A different classification, Forgetting isolated act (13.3.1), is possible:

The putting on of his respirator is an isolated act relative to the functional act of checking and opening the vacuum cleaner.

Case:

During normal operation of a process plant the power supply. to the instrumentation and the control console slowly disappears.

Investigation:

The manual main circuit breaker in the flywheel motor-generator supply is found to be in the off position. The conclusion of an investigation was that a roving operator, checking cooling towers and pumps, inadvertently had switched from a routine check round to the Friday afternoon shut down check round and turned off the supply.

The routes of the two check rounds are the same, except that-he is supposed to pass by the door of the generator room on the routine check, but to enter and turn off the supply on the shut down check. Something "en route" obviously has conditioned him for shut down check (sunshine and day

dreams?). The operator was not aware of his action, but did not reject the condition.

Comments:

Human operators move around in the plant, and it can be difficult to predict where in the causal structure of the plant he interferes. His actions may not be initiated by an event in the system or specified by a program, but by subconscious mechanisms, i.e. it is difficult to predict when he interferes and how.

13.2 communication

The two subcategories 13.2.1 and 13.2.2 are related to the man's activities in obtaining information.

So far, no mental malfunction mechanisms are included related to the man's communication directed outwards.

That an outwards communication malfunction has occurred, is classified under:

11: Internal human 'Malfunction

Erroneous function in action

Communication given incorrectly

13.2.1 Communication not received/sought, Definition:

Cues do not activate man because sensitivity/attention is insufficient for present information level.

13.2.1 -Communication not received/sought, Examples:

84. TECHNICIAN ERROR - RPS SETPOINTS WRONG

Ft. Calhoun - Dec (power escalation testing. The technician did not recognize that the set points were in violation of Tech Specs.

146. OPERATOR DID NOT CHECK SIGHTGLASS - RELEASE
Oconee 1 - Aug 74 - 100%. power

The procedure to drain accumulated moisture from the Waste Gas Decay Tank has a caution note to shut the drain valves as soon as water is clear of the sight glass. The operator failed to realize that the sight glass-was free of liquid, however, and this resulted in venting the Waste Gas Decay Tank to the High Activity Waste Tank.

178. PERSONNEL AND PROCEDURAL ERRORS - SAFETY INJECTIONS

Zion 1 & 2 - Aug, Oct

The testing included actuation of relay SIX-5A, which actuates a number of valves including the failed SI valve. Upon completion of the test, the valve remained open instead of returning to the closed position when manually actuated from the control room. This went unnoticed by the operators at the control board.

197. OPERATOR ERROR - RELEASE.

Surry I - Mar 75 - 100% power

An uncontrolled and unplanned release of low level radioactive material was made to the discharge canal when an operator error caused a primary grade water tank to overflow for 2 hr.

247. EMERGENCY POWER BATTERIES UNAVAILABLE FOR SERVICE- OPERATOR ERROR

Oconee 2 - Julv -5 - 100% power

During the process of planning the startup of unit 1 (Units 2 and 3 at full power), it was discovered that 1 string of Keowee (emergency power station! battery and 1 string of switching station

battery were being charged and were therefore out of simultaneously. Although the control operator notified that these batteries were to be taken out for service, he failed to recognize that they should not be taken out of service simultaneously.

13.2.2 Misinterpretation of communication, Definition:

Response is based on wrong apprehension of information such as mis-reading of text or instrument, misunderstanding of verbal message.

13.2.2 ***Misinterpretation of communication, Example:***

229. POWER LEVEL RAISED ABOVE CUTOFF PRIOR TO ESTABLISHING EQUILIBRIU, XENON

Oconee 2 - Mar 75 - 80%. power

The results of the 1320 calculation (March 22) were incorrectly interpreted in that they referenced 80% FP rather than 100% FP as required. That is the time that xenon would be within spec limits was based upon 90% of the 80% FP equilibrium value rather thin upon 90% of the 100". FP equilibrium value. The extrapolated time that the core would reach 90% of the 80% FP equilibrium xenon value was 18:30, March 22, and the calculation was so marked.

13. 2. 3 Assumptions replace observation, Definition:

Response is inappropriately based on information supplied by the operator (by recall, guesses, etc.) which does not correspond with information available from outside.

13. 2. 3 Assumptions replace observation, Examples:

160. INSTRUMENT AIR NOT VALVED OUT OF CONTAINMENT

Surry I - Jan 75 - cold shutdown

In establishing the valve line ups, the operator assumed that all valve numbers beginning with the number "2" were associated with Unit 2. He did not realize there were 2 valves in series from Unit I station instrument air system to Unit I containment with 2 more valves from Unit 2 station instrument air system to Unit No. I containment.

188. REACTOR BUILDING SPRAY SYSTEM IN0PERABLE DURING STARTUP - PROCEDURAL ERRORS

Oconee 2 Jan 75 - heatup in progress

The control operator assured that the review had been completed and no conditions existed which would prevent unit startup. In both cases, the lack of complete, accurate communications was at cause.

13. 3. 1 Forgetting isolated act or function, Definition:

Operator forgets to perform an isolated act or function, i.e., an act or function which is not cued by the functional context or is not having immediate effect upon the mental or motor sequence.

13.3.1 Forgettinq isolated act or function, Examples:

91. OPERATOR MISSED PRO'EDLTRAL STEP - SI - PRESSURE LIMIT EXCEEDED

Prairie Is. 1 - Jan 74

The transient occurred while conducting the Safeguards Logic Train A monthly surveillance test. A SI signal was initiated when a step which puts Train A in TEST was inadvertently missed. Completion of the subsequent step initiated-SI an a simulated low steam line pressure signal and opened Number 11 acumulator outlet valve.

191 DIESEL NOT TESTED

Cook 1 - Feb 75 (power escalation testing - 30% power

The failure of the operator to perform required surveillance on the standby DC when tagging a diesel for maintenance was the cause. CD DC should have been tested immediately after AB DG was removed from service and once every 8 hr thereafter per the Tech Specs.

205. PROCESS VENT SYSTFM RADIATION MONITOR LEFT IN CALBRATE

Surry I - Apr 75 - LGO'7 power

The Process Vent Gaseous Radiation monitor was found in the "Calibrate" mode. It was found to have been that way for the previous 24 hr. The monitor was placed in the calibrate mode to demonstrate its operation to a trainee. The monitor was then in-advertently left in that position. This resulted in a failure to monitor the Process Vent System for radioactive gases for a 24 hr period.

211. MAINTENANCE LEFT FEEDWATER PUMP PACKING TOO TIGHT

Oconee 3 - April 75 - 1oo%. power

Maintenance had been performed to repair a leaking packing gland prior to the failure. The packing was apparently set too tight and the pump was returned to service without verifying operability as is required by procedure.

213. HPSI VALVE STOPS NOT RESTORED

Maine Yankee - June 75 - shutdown

Evidently the valve mechanical stop adjustments had not been Properly restored following routine maintenance.

13.3.2 Mistake among alternatives, Definition:

Simple choice of wrong alternative, a category is correctly used but by wrong member, e.g., mistakes of up/down, left/right, A/B, open/closed, locked/unlocked.

13.3.2 Mistake among alternatives, Examples:

71. CORE FLOOD VALVE BREAKERS LOCKED CLOSED

Oconee I - Oct 73

During preparations for startup it was discovered that the breakers to the motor operators on CF-I and -2, the core flood tank discharge valves, had been locked in the closed position. Tech Specs and operating procedures require that these breakers be locked in the open position and tagged to prevent inadvertent isolation of the core flood tanks when the RCS is > 500 psig.

170 TECHNICIAN ERROR - WRONG TANK RELEASED

Palisades - Dec 74 - cold shutdown

The RRMC technician, when transposing the data to the batch card, wrote down the north tank instead of the south tank.

186. PROCEDURAL SAMPLING AND VALVING DEFICIENCTES - RELEASE

Cook 1 Feb 75 (power escalation testing)

Immediately prior to the event the North WECT had been filled, recirculated and sampled in preparation for the release. While waiting for the analytical results of the sample for the North WECT, it was isolated and the South WECT was filled and placed on recirculation. The release permit for the North WECT was approved but the North WECT was not placed in the proper valve line up and the South WECT was released instead of the North WECT.

239. LB SP.RAY OUT OF SERVICE

Oconee July and Aug

In the performance of the test, the Control Operator instructed the Utility Operator to open the breaker for valve lBS-2. A Utility Operator's trainee inadvertently opened the Unit -1 breaker for valve 28S-2, thereby removing one train of RB spray from service on an operating unit.

186 and 239 could possibly belong to: Topographic, spatial orientation inadequate (13.5.2).

13.3.3 Other slips of memory, Definition:

Erroneous recall of reference data values; names; need for actions, etc.

13-3.3 Other slips of-memory, Examples:

151. RFACTOR TAKEN CRITICAL WITH BORATED STORAGE TANK LOW

Rancho Seco - Oct 74 (subsequent to Initial criticality)

The Shift Supervisor had thought that the Tech Spec minimum volume was 350,000 gal and had proceeded accordingly.

13.4 Inferences

This group is covering problems of linear thought in causal nets.

13.4.1 Side effects or latent conditions not adequately considered, Definition:

The man is in a less familiar situation characterized by knowledge-based, goal-controlled performance. He performs erroneously during functional inferences: The situation is not properly identified, the consequences of an event chain are not adequately predicted or an improper aim is chosen or latent conditions are not adequately considered. Consequently, the task or the intended goal is not fulfilled or adverse side effects occur or a combination of these consequences.

(Can be due to oversight, lack of knowledge etc., this is characterized by category 12: cause of human malfunction).

13.4.1 Side effects or latent conditions not adequately considered, Examples:

193. OPERATOR ERROR - DIESEL BREAKER DID NOT CLOSE
Ft. Calhoun I - Mar 75 - refueling shutdown

DG 2 breaker IAD2 auto closed on bus lA4, however, DG breaker IAD1 failed to auto close on bus lA3. The operator then manually closed breaker 1ADI by control switch.

Breaker IAD1 did not and should not have auto closed onto bus IA3 in this instance. In order to complete the auto close circuitry for IADI ill 4160 V motors connected to bus IA3 must be tripped so the DC is not subjected to the large starting currents of multiple induction motors connected to the bus. In this case, low pressure SI pump SI-IA was in service providing shutdown cooling when the main transformer tripped. SI-IA breaker does not trip on undervoltage when its control switch is in the close position. If the operator had tripped SI-IA breaker, then the auto close circuitry for breaker 1AD1 would have been completed and IADI would have closed.

246. EFFLUENT CHLORINE EXCESSIVE - HYPOCHLORITE FILLING HOSE DRAINED INTO STORM DRAIN

Rancho Seco 1 - Apr -5

A check of plant activities revealed that a tank truck had made a deliverY of hypochlorite to the Nuclear Service Raw Water System Hypochlorite Storage Tanks and there was no spill of hypochlorite during the delivery. However, after filling the last tank, the driver drained the hose to the storm drain (4 gal).

193 is an example of "latent conditions" and 246 of "Side effects", though discrimination between these two types is often difficult.

13.5 Physical coordination

13.5.1 Motor variability, Definition:

Lack of manual precision, too big/small force applied, inappropriate timing. Including deviations from "good craftsmanship".

13.5.1 Motor variability, Examples:

162. RELEASE OCCURRED WHILE DRAWING VACUUM IN SG's - PROCEDURAL PROBLEM

Three Mi. Is. 1 - Nov 74

While in the process of returning to power after an outage, an unplanned release occurred due to some improperly tightened valves in the vent line from the Reactor Coolant (RC) Drain Tank to the Steam Generators (SG).

211. .MAINTENACE LEFT FEEDWATTER PU'MP PACKING TOO TIGHT

Oconee 3 - April 75 - 100% power

Maintenance had been performed to repair a leaking packing gland prior to the failure. The packing was apparently set too tight and the pump was returned to service without verifying operability as is required by procedure.

233. WIRE FELL ACROSS TERMINALS - INJECTION PUMP DAMAGED

Rancho Seco - July 74 (prior to initial fuel loading)

The High Pressure Injection-Pump started inadvertently when a short strand of wire fell across terminals accidentally jumpering the. control switches in the control room.

13.5.2 Topographic.-spatial orientation inadequate, Definition:

In spite of man's correct intention and his correct recall of identification marks, tagging etc., he unawaringly performs task/act in the wrong place or on the wrong object, because he is following his immediate sense of locality, this, however, not being applicable (not-updated, surviving imprints of old habits etc.).

13.5.2 Topographic, spatial orientation inadequate, Examples:

52 IMPROPER GROUND PLACED FOR A TEST - LOSS OF OFFSITE POVER

San Onofre I - June 73

A few hours- later it was determined that the unit differential relay operation was the result of the ground wire being inadvertently applied to the unit differential relay terminals located in the generator current transformer terminal box.9

114 OPERATOR RELEASED WRONG TANK

Oconee I - Apr 74

The apparent cause was Operator error in opening the incorrect tank isolation valve. The isolation valves for the 2 condensate test tanks are in close proximity and identified only by valve numbers. During release from the 3 tank, the 2 monitors did not show an increase in count rate, verifying the safe activity level of the water being released.

To prevent recurrence the condensate test tank isolation valves were to be more clearly identified to distinguish the A tank from the B tank.

130. WRONG VALVE REPAIRED - BORIC ACID TANK OUT
Oconee 1 - June 74

On 2 different days maintenance personnel mistakenly disassembled the Concentrated Boric Acid Storage Tank (C BAST) supply valve and this resulted in the isolation of the CRAST for a total of 55 min.

144. WRONG BREAKER OPENED - F-W PL'MP NOT AVAILABLE - LACK OF LOG ENTRIES

Prairie Is. I - Aug 74 - 100% power

The MCC for 22 AEVP is physically located near 12 AFWP. The MCC for 12 AFWP is located considerably further away. Someone, when maintenance was being performed and equipment being reinstalled on 22 AFVP, inadvertently opened the breaker for

12 AFWP Auxiliary lube oil pump. This action prevented the 12 AFWP from starting due to the lube oil pressure interlock.

No definitive examples have been found, nevertheless it is expected, that the category 13.5.2 will prove to be legitimate, if more detailed event information/analysis is provided.

The given examples should be regarded as samples of the present descriptive level of event reports, the malfunction mechanisms involved could belong to category 13.5.2, however, to other categories as well.